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Megymenum brevicorne F. Pentatomidae. (Hemiptera-Heteroptera) A Minor Pest of *Cucurbitaceae* and *Passifloraceae*.

BY

N. C. E. Miller.

Megymenum brevicorne first described by Fabricius in 1787, is a moderately large blackish "bug" belonging to the *Pentatomidae* or "shield bugs," a family included in the Order *Hemiptera—Heteroptera.*

The type of the genus *Megymenum,* which is distributed in the Oriental Region and in Australasia, is *M. dentatum* Boisd. This species occurs in New Guinea, whence it was first recorded. (1). (2).

M. brevicorne is rarely found in large numbers, therefore, for the present it may be accorded the rank of a minor pest.

Distribution.

In addition to being found in Malaya. *M. brevicorne* has been recorded as occurring in the following localities:—

Khasi Hills (Chennell); Calcutta (Ind. Mus.); Burma; Rangoon, (Fea); Nicobar Islands, (Coll. Dist.); and it is also reported from China. (1.)

Host Plants.

Up to the present, the nymphs and adults have been noticed as feeding on the following plants only. Grenadilla *Passiflora quadrangularis* L. (Mal. Timun hutan, T. belanda);

Pumpkin *Cucurbita maxima. Duch.* (Mal. Labu ayer, L. manis, Mendelikai; Semangka); Snake gourd *Trichosanthes anguina* L. (Mal. Ketola ular). (3). It is likely that other species of these genera are also attacked.

The stems and fruits are the parts of the plant preferred by this "bug."

Control.

The most simple method of dealing with this species is to collect the adults or nymphs in the early morning, by shaking them off the plants on which they are feeding, into a tin containing water with a film of kerosene on the surface.

The ova, although not very conspicuous may be discovered without undue labour and destroyed by crushing.

Description.

Ovum. Fig. 1. Cylindrical, tapering very feebly at each end; surface very finely punctate and covered with a whitish silky or wax-like substance.

Pale whitish green, turning to reddish before the eclosion of the nymph.

Fig. 1. Ova. Natural size 1.00 × .80 mm.

1st. instar nymph. Fig. 2. On emergence from the ovum, the nymph is pinkish dorsally, with the exception of abdominal segments 1, and 6 to 9 which are whitish. The abdomen ventrally is whitish with a fine pink maculation. In a short time, the nymph assumes the colours given in the following description.

Antennae light brown, suffused with pink.

Eyes light red.

Head, amber with a faint reddish suffusion on the vertex; outer margins of the juga, and margins of the projections in front of the eyes, reddish.

Nota, amber, with the lateral margins whitish and translucent.

Abdomen, dorsally, whitish with a pink suffusion on the lateral margins of the second segment; segments 3—7 almost entirely suffused with pink; segments 2—7 with a fine black maculation; lateral projections on segments 1—8 white, translucent; lateral projections on remaining segments amber; chitinized plates, on middorsum of abdomen, amber, darkest on segments 1—5; ventral segments of abdomen whitish, suffused with pink and with a fine blackish maculation.

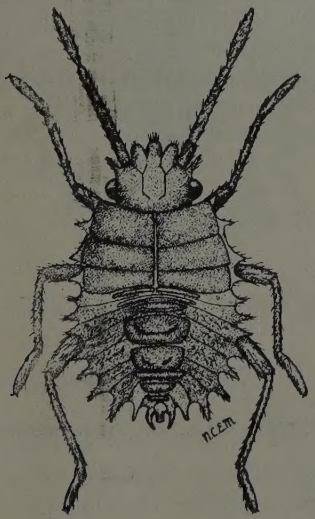

Fig. 2. 1st instar nymph. Natural size 2.30 mm.

Ventral surface of head, rostrum and sternites amber,

Femora and tarsi amber; tibiae very pale amber with a pink suffusion along the inner margin.

Elliptical. Antennae robust and with scattered setae.

Head with a projection in front of the eyes; juga and tylus feebly setose.

Thorax and abdomen with the lateral margins produced, flattened and mucronate; margins of lateral projections very feebly tuberculate and setose.

Legs, robust; femora and tibiae feebly setose, the setae arising from low tubercles.

The abdominal segments dorsally have chitinised plates, of various shapes, three of which, i.e., those on segments 3, 4 and 5 bear the pores of the odoriferous glands. The forms of these dorsal plates are, as follows;—Segment 1. narrow, oblong and feebly arcuate; segment 2. oblong and feebly arcuate; segment 3, fusiform; segment 4, trapeziform with the lateral margins and anterior margin feebly convex; segment 5, similar to that on 4 but narrower; segment 6, concavo-convex, with the anterior margin concave; segment 7 narrow, trapeziform, with lateral margins convex; segment 8, plano-convex, with the anterior margin straight; segment 9, quadrate with the lateral margins feebly rounded.

Total length. 2.30 mm.

Length of antennal segments.

1.	2.	3.	4.
.25 mm.	.40 mm.	.39 mm.	.60 mm.

2nd. instar nymph. Fig. 3. Antennae and head light piceous.

Eyes dark red.

Nota whitish, almost entirely suffused with dark brown; apex of projections on lateral margins of pro and meso nota dark brown; projections on metanotum entirely whitish.

Abdomen, dorsally whitish, with all the segments except segment 1, suffused with dark brown; lateral projections on all segments except 1 and 8 suffused with dark brown in the basal half; dorsal plates on mid dorsum of abdomen, brown.

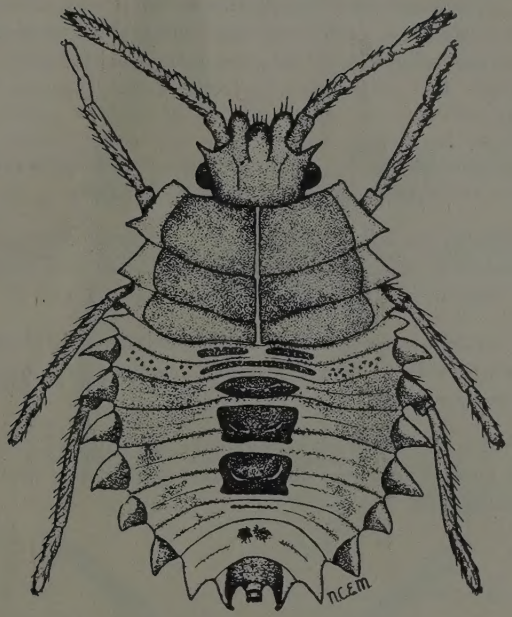

Fig. 3. 2nd instar nymph. Natural size 4.00 mm.

Ventral surface of head blackish brown; rostrum pale olive.

Sternites brownish, suffused with black;

Ventral surface of abdomen whitish, with a faint brownish maculation and a brownish suffusion on segments 5—8 medially.

Femora pale olive green; tibiae and tarsi greenish white.

The form assumed by the nymph in this instar, is similar to that of the 1st. instar, but is more rounded. The dorsal plates of abdominal segments 1 and 2 are irregular and those on segments 7—8 indistinct.

Total length. 4 mm.

Length of antennal segments.

1.	2.	3.	4.
.30 mm.	.60 mm.	.50 mm.	.60 mm.

3rd. instar nymph. Fig. 4. On eclosion, the antennae are violaceous, the eyes dark red, the head pale greenish with a violaceous suffusion along the outer margin of the juga and on the vertex. The projections in front of the eyes are reddish violaceous.

Nota, whitish, with a strong reddish maculation and a deep olivaceous suffusion towards the lateral margins.

Abdomen, dorsally, whitish with a ferrugineous suffusion and maculation, and with an orange suffusion and maculation on each side of the middorsum of segments 1 and 2.

The nymph becomes more darkly coloured in about three hours, and then the nota are strongly maculate with brown and dark olive green.

Dorsally, the abdominal segments are suffused and maculate with dark olive green, the suffusion being most pronounced on segments 3—6.

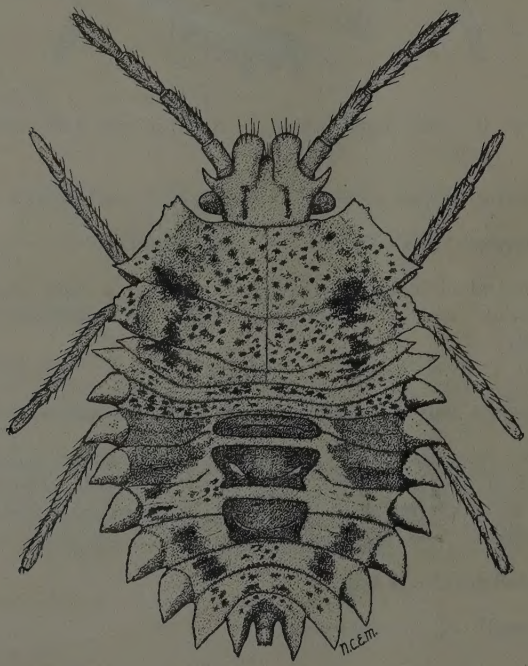

Fig. 4. 3rd instar nymph. Natural size 5.00 mm.

Segments 2 and 3 of the antennae of the 3rd. instar nymph are somewhat compressed dorso-ventrally, and the eyes more elongate than those of the nymphs of the preceding instars.

The outer margin of the pronotum is somewhat concave, and the dorsal plates are absent from abdominal segments 1 and 2 and 6 to 9. The dorsal plate on the 3rd. segment becomes oblong, with the lateral margins rounded.

The head and body are powdered with a white wax like substance.

Total length. 5 mm.

Length of antennal segments.

1.	2.	3.	4.
.40 mm.	.80 mm.	.70 mm.	.85 mm.

4th. instar nymph. Fig. 5. Antennae blackish brown. Eyes dark red.

Head light brown, with a dark brown maculation on the juga and a dark brown suffusion on the vertex.

Pro and meso nota whitish, strongly maculate and blotched with dark brown and black; metanotum whitish with some light and dark brown spots.

Abdomen dorsally whitish, strongly maculate and suffused with black and brown, the suffusion being most pronounced on segments 3, 4 and 6; dorsal plates light brown with a black maculation and suffusion; lateral projection on abdomen except on segments 1 and 8, with a moderately broad black border, suffused with light brown along its anterior margin, along their posterior margins; ventral surface of abdomen pale brownish white strongly maculate with brown and black and with an irregular longitudinal black stripe near the inner margins of the spiracles; spiracles black.

Pro and meso sterna pale brownish white, with a black confluent maculation; meta-sternum pale brownish white, with a large irregular black patch.

Ventral surface of head and thorax finely powdered with a white wax like substance.

Femora and tarsi dark olive green; tubercles on femora blackish; tibiae pale bluish green immediately after ecdysis. A day after ecdysis the femora and tibiae become whitish with the tubercles dark brown, and the tarsi become brownish.

Fig. 5. 4th instar nymph. Natural size 7.00 mm.

The principal points of difference between the 4th. instar nymph and the 3rd. instar nymph, are, the approximation of the inner margins of the juga, and the narrowing in length and breadth of the meta-notum, of which the lateral margins are rounded, and do not have a mucronate projection. The posterior margin of the mesonotum is strongly sinuate, and that of the metanotum almost straight.

Total length. 7 mm.

Length of antennal segments.

1.	2.	3.	4.
.60 mm.	1.30 mm.	1.05 mm.	.90 mm.

5th. instar nymph. Fig. 6. Antennae blackish brown with a faint violaceous suffusion at the base of each segment

Eyes dark ferrugineous.

Vertex brownish ochraceous, strongly maculate with black, most of the spots being coalescent; juga with two longitudinal black patches at the base.

Pronotum brownish ochraceous, strongly maculate with black, and with some light brown spots along the median line; near the anterior angles the spots coalesce very strongly, forming a dark patch; on each side of the median line is a pale brownish crescentic marking.

Rudiments of scutellum and hemielytra ochraceous with a fairly dense black maculation, and irregular dark brownish patches.

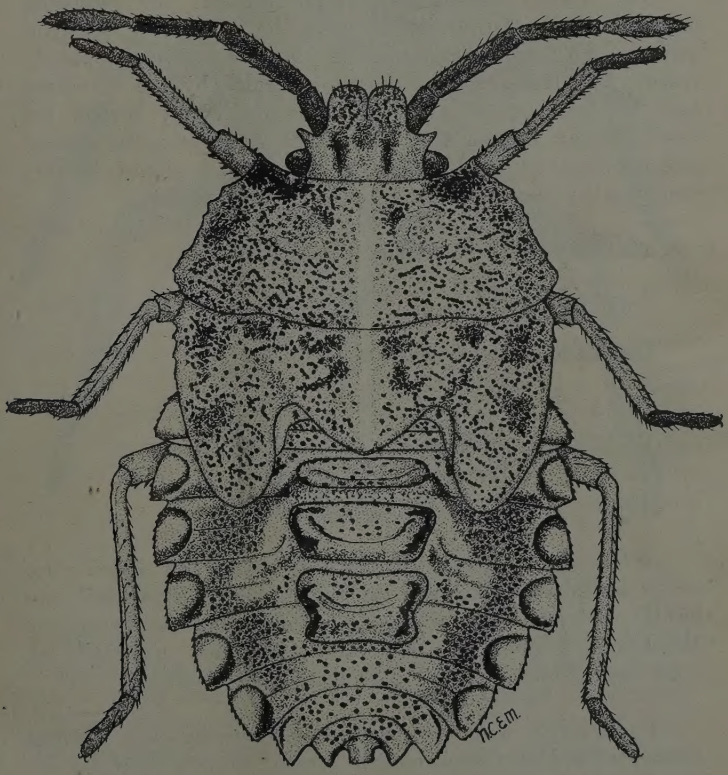

Fig. 6. 5th instar nymph. Natural size 10.50 mm.

Dorsal surface of abdomen whitish ochraceous, very strongly maculate with black and with an irregular, almost immaculate area around the dorsal plates; lateral projections on abdomen with a blackish crescentic marking on the inner margin.

Femora greyish, with a black maculation; tibiae brownish, with a dark brown maculation; tarsi blackish brown.

Sternites whitish ochraceous with a coalescent black maculation.

Ventral surface of abdomen whitish ochraceous, with a strong black maculation which is very dense and coalescent along the inner margin of the spiracles. Spiracles black.

The nymph of the 5th. instar presents the following features which distinguish it from the nymph of the 4th. instar. The inner margins of the juga are almost completely fused. The metanotum is almost concealed by the scutellum and the rudiments of the hemielytra reach just beyond the basal margin of the 4th. abdominal segment. The lateral projections on the 2nd abdominal segment are almost entirely concealed by those on the 1st abdominal segment.

The spines on the femora are more robust.

Total length. 10.50 mm.

Length of antennal segments.

1.	2.	3.	4.
.70 mm.	1.60 mm.	1.30 mm.	1.20 mm.

Adult. Fig. 7. Eyes dark ferrugineous.

Whole body, except the membrane of the hemielytra, wings, and dorsal surface of the abdomen, cupreous black, and lightly covered with a whitish ochraceous wax-like substance. Membrane of hemielytra ochraceous, somewhat infuscated beyond the middle. Venation on membrane brownish.

Connexivum with pale brownish ochraceous spots. Dorsal surface of abdomen dark reddish brown, slightly paler basally and greyish on the lateral margins near the apex.

Ventral surface of whole insect rather more thickly covered than the dorsal surface, with the whitish wax-like substance. Spiracles shining piceous.

Legs black. Wings infumate.

Fig. 7. Adult ♂. Natural size 10.73 mm.

Elliptical. Segments 2 and 3 of the antennae somewhat compressed dorso-ventrally; segment 2 with a feeble longitudinal sulcus near the posterior margin; surface of segments 1, 2 and 3 longitudinally striate and with scattered short setae; segment 4, fusiform, strongly hirsute with the surface of the basal third longitudinally striate, and of the apical two thirds smooth or very finely punctate, shining.

Head strongly depressed anteriorly; lateral margins rounded or rotundato angulate before the eyes; surface strongly rugose punctate.

Surface of pronotum strongly and irregularly punctate and rugose, with irregular depressions and with a rounded tumescence, about a third as broad as the anterior margin near the anterior margin, at its centre; anterior margin sinuate, produced laterally; lateral margins strongly concave in the apical third and almost straight but irregular in the basal two thirds; posterior margin broadly rounded.

Scutellum strongly and irregularly punctate, irregularly impressed, rounded apically and with a deep elongate depression on each side of the base.

Corium finely striate and irregularly punctate.

Connexivum punctate; lateral projections of connexivum rounded.

Ventral surface of abdomen strongly and irregularly punctate.

Area around odoriferous gland apertures on meta sternum rugose.

Femora with mucronate processes on the posterior margin near the apex. Tibiae feebly longitudinally sulcate and strongly setose on the posterior margin, the setae being longer and more robust near the apex.

Average total length.

	Male.	...	Female.
	10.73 mm.		12.46 mm.
Maximum.	11.50 mm.		14.00 mm.
Minimum.	10.00 mm.		11.80 mm.
Difference.	1.50 mm.		2.20 mm.

Length of antennal segments.

	1.	2.	3.	4.
Male.	.60 mm.	1.60 mm.	1.40 mm.	1.20 mm.
Female.	.90 mm.	2.1 mm.	1.50 mm.	1.40 mm.

Life History.

The female *Megymenum brevicorne* deposits her ova in a chain, end to end. They are fairly thickly covered with a whitish wax-like substance in the form of fine threads and small granules.

The ova are laid on the upper or lower sides of the leaves, or on the stems of the foodplant.

Eighteen, was the greatest number of ova deposited in the laboratory by a single female.

The nymphs emerge by forcing up the circular operculum which is situated on the upper side at one end of the ovum. A few hours before the time of hatching, the embryo nymph may be seen through the chorion of the ovum, which then has a reddish appearance.

At the time of hatching the nymph is pinkish, with some white on the abdomen.

The nymphal stages differ very slightly from each other. The most noticeable differences are to be seen in the shape of the head and thorax. The colouration becomes darker and the spots and markings are more dense following each ecdysis.

Possibly, less evident is the gradual disappearance from the dorsal surface of all the abdominal segments, except 3 to 5, when the 3rd. instar is reached, of the chitinized portions of the integument,† or dorsal plates as they have been named Three of these dorsal plates—i.e., those on segments, 3, 4 and 5—bear the pores of odoriferous glands. As is usual, all these plates disappear when the adult stage is reached.

After the third moult has taken place, the rudiments of the hemielytra are to be seen, and, after the fourth moult they shew a marked increase in length, reaching beyond the anterior margin of the 4th. segment of the abdomen.

As regards the head, the main differences to be seen, are, the alteration in shape of the flattened lobes or juga which form the front part of the head, and the modification of the mucronate process in front of the eyes, which persists throughout the nymphal stages.

†It has recentlybeen suggested (4) that "sclerotised" be substituted for "chitinised," which is technically inaccurate, but since the designation "chitinised" is so generally understood it is thought that it is preferable to continue to employ it.

This mucronate process, when the adult stage is reached is reduced to a rounded or rotundato-angulate projection.

The lateral margins of the abdomen are serrate, with each "tooth" pointed and with short spines on the margins. In the adult stage the shape of the lateral margins of the abdomen is still serrate, but the "teeth" are considerably shorter and are rounded.

The adult insect of both sexes is entirely black or coppery black, but, owing to the presence of a whitish wax like substance, which is powdered over the whole body, except the wings, it appears greyish.

The membranous portion of the hemielytra is pale ochraceous, with an irregular dark brown shading, which is most pronounced along the veins.

Under laboratory conditions, the nymphs thrive equally well, whether placed singly in breeding cages, or whether placed together.

There is a tendency towards gregariousness when several nymphs or adults are housed together.

Both nymphs and adults have the curious habit of vibrating the antennae when disturbed.

The average duration of the instars is as follows:—

1st. instar.	10.10 days.
2nd. instar.	8.50 days.
3rd. instar.	9.75 days.
4th. instar.	15.30 days.
5th. instar	30.25 days.
Adult stage.	11.75 days.

These figures are based on the results of rearing eight individuals in the laboratory. The total life cycle from the the deposition of the ova to the death of the adults was 94.15 days.

The details of these figures are given in the table on page 436.

Conclusion.

The writer is indebted to Mr. W. E. China of the British Museum (Natural History), London, for his suggestions in connection with the subject of repugnational glands and to Che Kamardin bin Bahar for keeping the breeding records.

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4. Snodgrass, R. E. Some Further Errors of Body Wall Nomenclature in Entomology. Entomological News Vol. XL, No. 5, p. 150. May 1929.

Number.	1	2.	3.	4.	5.	6.	7.	8.
Date of oviposition -	8.10.28	8.10.28	8.10.28	8.10.28	8.10.28	8.10.28	8.10.28	8.10.28
Date of hatching -	15.10.28	15.10.28	15.10.28	15.10.28	18.10.28	18.10.28	18.10.28	18.10.28
Incubation period -	7 days	7 days	7 days	7 days	10 days	10 days	10 days	10 days
Date of first moult -	25.10.28	25.10.28	27.10.28	27.10.28	30.10.28	30.10.28	28.10.28	28.10.28
Period of first instar -	10 days	10 days	12 days	12 days	12 days	12 days	10 days	10 days
Date of second moult -	5.11.28	30.10.28	5.11.28	4.11.28	7.11.28	8.11.28	8.11.28	3.11.28
Period of second instar -	11 days	5 days	10 days	8 days	8 days	9 days	11 days	6 days
Date of third moult -	14.11.28	12.11.28	15.11.28	14.11.28	16.11.28	17.11.28	17.11.28	13.11.28
Period of third instar -	9 days	13 days	9 days	10 days	9 days	9 days	9 days	10 days
Date of fourth moult -	26.11.28	28.11.28	29.11.28	30.11.28	5.12.28	3.12.28	29.11.28	1.12.28
Period of fourth instar -	12 days	16 days	14 days	16 days	19 days	16 days	12 days	18 days
Date of fifth moult -	22.12.28	29.12.28	29.12.28	2. 1.29	10. 1.29	29.12.28	29.12.28	31.12.28
Period of fifth instar -	26 days	31 days	30 days	33 days	36 days	26 days	30 days	30 days
Date of death of adult -	31.12.28	11. 1.29	17. 1.29	10. 1.29	23. 1.29	17. 1.29	7. 1.29	4. 1.29
Life of adult -	9 days	13 days	19 days	8 days	13 days	19 days	9 days	4 days

A note on the ash of Nipah Juice and some experiments on preservation using Alcohol and Heat as sterilising agents and Copper Sulphate and Lime as preservatives.

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Two samples of nipah juice have been examined for mineral ash constituents one sample of which was from cultivated palms and one sample from indigenous palms situated in the Kuala Selangor District.

The following results of analysis were obtained. Constituent in grams per 100 cc of juice.

		(a) Cultivated palms.	(b) Indigenous palms.
	Nitrogen ...	0.036	0.047
	Ash ...	0.630	0.575
On Ash.			
	Potash (K_2O) ...	0.227	0.183
	Phosphorus (P_2O_5) ...	0.025	0.024
	Chlorides (Cl) ...	0.187	0.185
	Sulphates (SO_3) ...	0.012	0.020
	Iron & Alumina ($Fe_2O_3 + Al_2O_3$) ...	0.018	0.022
	Calcium (CaO)	0.008	0.008
	Magnesium (MgO) ...	0.005	0.013

Preservation Experiments.

It has been pointed out [1] that owing to the universal presence of yeasts in the local atmosphere nipah juice in the natural state rapidly undergoes inversion and fermentation and the experiments enumerated below were designed to ascertain the possibilities of arresting the reactions either in part or whole.

1. M. A. J. Vol. XV, December 1927, page 440.

It has been shewn previously that sulphuric acid [2] could be used for the purpose of greatly retarding fermentation though by its very nature it has an accelerating effect on inversion. It has been further shewn that alcohol[2] if present in sufficient quantity would stop all reactions.

As the result of a long series of observations it was realised that the inversion and fermentation which occurred in nipah juice on any given day was chiefly due to the action of yeast which had entered the collecting vessel two or three days previously rather than to that which entered on the day of collection and it therefore seemed probable that if this yeast from previous collections could be suitably poisoned each day a fairly sterile or at least uninverted unfermented juice would be obtained.

Gibbs shewed that the juice can be preserved with lime and this method was used in this Department to prepare a sample of sugar. [3]

It was decided to try the addition to the collecting vessels of sufficient alcohol to sterilise the yeast present, subsequently removing the majority of the alcohol before tapping started, thus operating with more or less sterile vessels. A further series of experiments was made in which the collecting vessels were completely sterilised by boiling.

Further it seemed possible that the juice might be made poisonous to yeast by the addition of a cheap toxic salt such as copper sulphate.

Experimental.

It is to be realised that whereas a small scale experiment of this nature may be quite successful, other factors (e.g. labour) may modify the results obtained in practice.

The following experiments therefore were carried out with the idea of indicating useful lines to be tried out on a practical scale.

(i) Collecting vessels flushed out thoroughly each day and in some cases twice a day with 95% alcohol, the alcohol being returned to its original container and used again daily until it became too dilute to have any effect.

2. M. A. J. Vol. XIV. December, 1926.
3. M.A.J. March 1923. Philippine Journal of Science 1911 & 1912.

(ii) As above with the addition of one per cent. copper acetate to the alcohol used for flushing.

(iii) Collecting vessels sterilised by boiling.

(iv) Collecting vessels flushed with dilute solution of copper acetate.

(v) Copper sulphate added to the collecting vessels both solid and in solution.

(vi) Lime added to the collecting vessels.

The collecting vessels were glazed throughout, in the first five experiments glass bottles were used while in (vi) glazed earthenware pots were used, all previous experiments with lime having been made with porous vessels.

The results obtained are tabulated on pages 441 to 448 together with remarks on the individual experiments.

Summary.

The following general observations are offered on the results obtained.

(i) By a process of washing the collecting vessels with alcohol and collecting the juice every twenty four hours fermentation can be largely inhibited, being reduced to an approximate mean alcoholic content (apart from some of the added alcohol which remains in the bottle) of less than one per cent. as against 4.3 per cent. with untreated vessels. The ratio of invert sugar to total sugar can be reduced from 0.91 to 0.48 (circa 7% per cent.)

(ii) By heat sterilisation of the collecting vessels a similar inhibition of fermentation and reduction of inversion can be brought about.

(iii) By a combination of occasional heat sterilisation and alcohol flushing of the vessels fermentation and inversion is further reduced.

(iv) The retarding effect is very greatly increased by collection every twelve instead of every twenty four hours.

(v) Washing the bottles with a 1% solution of copper acetate combined with occasional sterilisation and twelve hour collection, has a very marked effect both on the prevention of inversion and fermentation.

(vi) When a solution containing about 0.6 grams or upwards of copper sulphate is added to the collecting vessel fermentation is almost completely inhibited, but the effect on inversion is not marked.

(vii) The maximum effect which can be obtained by a a three day sterilisation period combined with washing of the bottles with alcohol containing one per cent. of copper acetate and collecting every twelve hours, reduces the acidity to 0.055 per cent. as against 0.41 for unpreserved juice, the alcohol to about 0.2 as against 4.3 and the ratio of invert to total sugar to 0.155 as against 0.91 for untreated juice implying an invert sugar content of about 2.4 to a total of about 15.4 per cent.

(viii) By the addition of lime to the collecting vessels fermentation can be stopped and inversion retarded to a sufficient degree when lime is present to the extent of about four or five grams for a probable collection of 20 oz. of juice.

Experiment.	Days Alcohol in use.	Collection.	Particulars of preservation.	Sample.	Acidity per cent. as Acetic.	Invert Sugar per cent.	Total Sugar per cent.	Ratio Invert / Total.	Alcohol per cent. by Volume.	Alcohol equivalent as per cent by Volume.	Remarks.
			None. Juice straight from palms about 1 hour after cutting spathe.	Bulked from 12 palms	0.012	0.046	16.6	0.00277	nil.	11.0	This sample of juice fresh from the spathes taken more or less as a standard.
	1	Once daily	Alcohol treated	Individual spathe.	0.200	2.2	16.8	0.55	5.6 (0.0)	11.2	Examined A.M. about 27 hours from time of first flow of juice.
			,, ,,	,,	0.210	...	13.8		6.5 (0.8)	9.2	Alcohol equivalent calculated on sugar content only. Figures in brackets probable alcohol content due to fermentation balance of alcohol due to added preservative obtained by subtracting figures in brackets from total alcohol present.
			,, ,,	,,	0.185	11.2	13.4	0.837	10.5 (1.1)	8.9	
			,, ,,	,,	0.170	9.5	13.0	0.730	5.0 (1.5)	8.4	
A.											
	2	Once dialy	,, ,,	,,	0.110	4.0	15.8	0.254	0.5 (0.5)	10.5	Same remarks apply as to first set of samples above.
			,, ,,	,,	0.150	6.4	14.5	0.440	0.65 (.25)	9.6	
	16	Once daily	,, ,,	Bulk 2 spathes	0.240	11.0	11.5	0.957	2.8 (2.3)		The same remarks apply as to first set above. The alcohol used here has been in use for 16 days and has become diluted to such an extent that it has little effect on inversion and much less on yeast inhibitation than before.
			,, ,,	,,	0 300	9.4	10.5	0.892	3.2 (3.1)		
			,, ,,	,,	0.300	9.0	9.9	0.910	4.2 (3.4)		
			,, ,,	,,	0.440	10.1	10.7	0.945	5.0 (2.9)		

Experiment	Days Alcohol in use.	Collection	Particulars of preservation.	Sample.	Acidity per cent. as Acetic.	Invert Sugar per cent.	Total sugar per cent.	Ratio $\frac{\text{invert}}{\text{Total.}}$	Alcohol per cent by Volume.	Alcohol equivalent as per cent by Volume.	Remarks.
A.	1	Once daily	Control	Individual spathe.	0.330	6.6	7.2	0.916	6.7	11.2	Parallel samples to above.
			,,	,,	0.390	6.8	6.9	0.985	4.2	8.8	Examined same time after tapping.
			,,	,,		4.4	4.4	1.000	7.15	10.9	
	2	Once daily	,,	,,	0.350	9.7	11.5	0.843	2.9	10.5	Examined same time after tapping.
			,,	,,	0.370	9.3	10.3	0.902	3.6	10.3	In case of controls fresh samples collected daily Figure in second column merely indicates the treated sample to which they correspond.
	16	Once daily	,,	Bulk 2 spathes.	0.330	7.5	7.6	0.986	4.85	9.9	
			,,	,,	0.400	6.9	7.1	0.975	4.65	9.35	
			,,	,,	0.500	5.5	5.5	1.000	4.25	9.05	
			,,	,,	0.525	5.3	5.4	0.980	5.95	9.6	
B.	1	Once daily	Alcohol treated	Bulk 20 spathes.	0.156	6.4	12.6	0.507	2.55 (1.6)	8.4	Fresh alcohol used. The same remarks apply as to first set above.
			,, ,,	,,	0.114	6.4	15.4	0.415	2.3 (nil)	10.1	
	14	Once daily	,, ,,	,,	0.198	10.1	13.8	0.745	7.1 (1.4)	9.15	Alcohol in use for 14 days still an effect on preservation, very little on inversion.
			,, ,,	,,	0.240	11.1	15.3	0.721	3.3 (.3)	10.2	
	15	Once daily	,, ,,	,,	0.144	8.7	14.1	0.615	...	...	

Experiment.	Days Alcohol in use.	Collection.	Particulars of preservation.	Sample.	Acidity per cent as Acetic.	Invert Sugar per cent.	Total Sugar per cent.	Ratio Invert / Total.	Alcohol per cent by Volume.	Alcohol equivalent per cent by Volume.	Remarks.
B.	1	Once daily	Control	Bulk 20 spathes.	0.470	7.5	8.4	0.891	5.05	10.5	
	14	Once daily	,,	,,	0.365	11.1	11.7	0.950	2.5	10.3	
			,,	,,	0.420	10.0	10.6	0.945	2.4	9.4	
	15	Once daily	,,	,,	0.354	9.1	9.1	1.000	...	...	
C.	1	Once daily	Alcohol treated	Bulked 20 spathes.	0.210	6.9	13.8	0.500	6.5 (1.0)	9.2	Alcohol equivalent on sugar content only.
	4	,, ,,	,, ,,	,,	...	9.3	16.2	0.575	...	10.3	
	7	,, ,,	,, ,,	,,	...	11.4	14.8	0.770	...	9.8	
	1	,, ,,	Control	,,	0.490	6.9	10.1	0.682	3.5	10.2	
D.	1	Once daily	Bottle sterilised and alcohol treated.	,,	...	4.6	18.2	0.253	nil	12.1	Same batch of alcohol in use as in C. above.
	3	,, ,,	3 days after sterilising alcohol treated.	,,	...	9.5	17.2	0.552	nil	11.4	

Experiment.	Days Alcohol in use.	Collection.	Particulars of preservation.	Sample.	Acidity per cent. as Acetic.	Invert Sugar per cent.	Total Sugar per cent.	Ratio $\frac{\text{Invert}}{\text{Total}}$.	Alcohol per cent by Volumee	Alcohol equivalent as per cent by Volume.	Remarks.
E.	1	Twice daily	Alcohol + 1% Cu. Acetate Bottles sterilised	Bulked 20 spathes.	0.042	2.0	14.8	0.135	5.5 (0.4)	9.8	Inversion and acidity gradually increase as time elapses from the first day. Bottles gradually being infected with active invertase.
	2	,, ,,	Alcohol +1% Cu. Acetate One day after sterilising.	,,	0.030	0.83	16.2	0.051	1.9 (nil)	10.7	Total sugar remarks more or less constant throughout.
	3	,, ,,	Alcohol + 1% Cu. Acetate Two days after sterilising.	,,	0.092	4.3	15.3	0.281	2.5 (nil)	10.2	Better results than with alcohol alone.
	4	,, ,,	Alcohol + 1% Cu. Acetate Three days after sterilising.	,,	0.150	6.9	14.9	0.463	1.5 (0.4)	9.85	Alcohol equivalent calculated on sugar content only. Probable alcohol due to fermentation given in brackets.
	4	,, ,,	do (second collection)	,,	0.250	4.1	15.1	0.272	1.3 (nil)	10.0	
	5	,, ,,	Alcohol + 1% Cu. Acetate Four days after sterilisiug.	,,	0.186	6.5	16.5	0.393	2.3 (nil)	10.9	
	6	,, ,,	Alcohol + 1% Cu. Acetate Five days after sterilising.	,,	0.204	6.4	13.4	0.480	2.55 (1.8)	8.85	

Experiment.	Days Alcohol in use.	Collection.	Particulars of preservation.	Sample.	Acidity per cent as Acetic.	Invert Sugar per cent.	Total Sugar per cent.	Ratio Invert / Total.	Alcohol per cent. by Volume.	Alcohol equivalent as per cent by Volume.	Remarks.
F.	1	Once daily	Alcohol Cu Acetate Bottles sterilised on first day	Bulked 20 spathes.	0.138	3.75	16.2	0.232	1.1 (nil)	10.7	Rather more invert sugar than twice daily collection.
	2	,, ,,	Alcohol Cu Acetate	,,	0.190	5.9	15.1	0.390	2.3 (nil)	10.0	
	3	,, ,,	,, ,,	,,	0.270	8.3	13.7	0.605	2.3 (1.2)	9.1	
	5	,, ,,	,, ,,	,,	0.216	6.2	13.4	0.465	2.3 (1.4)	8.85	
G.	1	Twice daily	1% Cu. Acetate Bottles sterilised on first day.		0.180	3.9	15.0	0.260	0.45	10.4	
	2	,, ,,	,, ,,	,,	0.150	3.1	16.7	0.186	nil	11.1	
	3	,, ,,	,, ,,	,,	0.150	2.0	14.5	0.138	0.4	9.8	2nd collection.
	4	,, ,,	,, ,,	,,	0.156	2.6	14.0	0.186	0.3	9.55	
	4	,, ,,	,, ,,	,,	0.250	4.1	15.1	0.271	1.3	11.3	
	5	,, ,,	,, ,,	,,	0.246	6.5	14.5	0.448	2.1	11.6	
	6	,, ,,	,, ,,	,,	0.174	4.3	12.3	0.350	1.32	9.45	

Experiment.	Day Alcohol in use.	Collection	Particulars of preservation.	Sample.	Acidity per cent as Acetic.	Invert Sugar per cent.	Total Sugar per cent.	Ratio Invert / Total.	Alcohol per cent by Volume.	Alcohol equivalent as per cent by Volume.	Remarks.
H.		Once daily	Control on all above E, F & G. Bottles sterilised first day.	Bulked 20 spathes.	0.450	8.4	11.8	0.713	2.5	10.3	
		" "	" " "	"	0.400	8.0	9.2	0.865	4.5	10.6	
		" "	" " "	"	0.400	8.0	9.3	0.860	4.4	10.5	
		" "	" " "	"	0.420	7.5	8.0	0.940	4.5	9.8	
I.		Once daily	.5 gms. Cu SO_4 $5H_2O$ added to bottle	Single spathe.	...	11.0	11.0	1.00	...	?	Samples examined after keeping for 24 days after tapping.
		" "	1.5 gms " "	"	...	17.2	17.8	0.97	...	11.8	
		" "	2.0 gms " "	"	...	15.1	15.2	0.99	...	10.1	
J.		Once daily	0.5 gms Cu So_4 $5H_2O$	Bulked 6 spathes.	...	11.0	13.8	0.80	2.1	11.2	Ground copper sulphate added in the quantities stated to the collecting vessels.
		" "	0.75 " "	"	...	13.3	13.9	0.96	2.1	11.3	
		" "	1.00 " "	"	...	6.9	13.6	0.51	1.2	10.2	
		" "	1.25 " "	"	...	9.2	14.0	0.66	1.0	10.3	
		" "	0.00 " Control	"	...	10.4	10.4	1.00	3.3	10.2	

Experiment.	Days Alcohol in use.	Collection.	Particulars of preservation.	Sample.	Acidity per cent as Acetic.	Invert Sugar per cent.	Total Sugar per cent.	Ratio $\frac{\text{Invert}}{\text{Total.}}$	Alcohol per cent by Volume.	Alcohol equivalent as per cent by Volume.	Remarks.
K.		Once daily.	.5 gms. $CuSO_4$	Bulked 6 spathes.	...	13.1	13.3	0.98	2.5	11.2	Very little further fermentation has occurred in the treated samples.
		,, ,,	.75 ,, ,, same samples	,,	...	13.8	13.9	0.99	2.1	11.3	
		,, ,,	1.10 as J	,,	...	9.3	13.6	0.68	1.2	10.2	
		,, ,,	1.25 ,, ,, examined 16 hours later.	,,	...	11.5	14.0	0.82	1.0	10.3	
		,, ,,	0.00 ,, Control.	,,	...	7.7	7.7	1.00	5.1	10.2	
L.		Twice daily	0.00 gms. Control.	,,	...	10.6	10.6	1.00	4.5	11.5	It is probable that the preliminary fermentation which occurs is due to the formation at first of two layers copper sulphate going into solution slowly from the bottom and fermentation occurring in the upper layer before the copper sulphate has become homogenously distributed.
		,,	0.5 ,, $CuSO_4 5H_2O$	,,	...	9.8	13.8	0.71	1.4	10.5	
		,,	0.75 ,, ,,	,,	...	7.6	14.8	0.51	0.8	10.6	
		,,	1.00 ,, ,,	,,	...	6.2	14.8	0.42	0.6	10.4	
		,,	1.25 ,, ,,	,,	...	2.4	16.2	0.15	0.3	11.0	

Experiment.	Days Alcohol in use.	Collection.	Particulars of preservation.	Sample.	Acidity per cent, as Acetic	Invert Sugar per cent.	Total Sugar per cent.	Ratio Invert / Total.	Alcohol per cent by Volume.	Alcohol equivalent as per cent by Volume.	Remarks.
M.		Once daily.	.6 gms. copper sulphate as solution.	Bulked 6 spathes.	...	7.5	15.9	.472	nil	10.5	
		,, ,,	,,	,,	...	8.4	15.2	.552	nil	10.1	
		,, ,,	,,	,,	...	6.7	14.5	.463	nil	9.6	
		,, ,,	,,	,,	...	9.3	14.8	.628	1	9.9	Fermentation almost completely arrested. Effect on inversion insufficient.
		,, ,,	.9 ,, ,,	,,	...	11.2	16.0	.700	nil	10.6	
		,, ,,	,,	,,	...	8.5	13.7	.621	3	9.4	
		,, ,,	,,	,,	...	7.1	15.8	.450	nil	10.5	
		,, ,,	,,	,,	...	8.9	16.2	.550	nil	10.7	
N.		Once daily.	Lime 1 gm. approx.	Bulked 6 spathes	0.25	6.0	10.0	.600	...	..	Some fermentation occurring.
		,, ,,	,, ,, ,,	,,	0.20	4.5	11.1	.405	...	...	Some fermentation occurring.
					Alkalinity as $Ca(HO)_2$						
		,, ,,	Lime 2 gms. approx.	,,	0.148	1.6	13.9	.115	...	8.8	Good state of preservation.
		,, ,,	,, 4 ,,	,,	0.285	1.5	14.1	.106	...	8.9	Good state of preservation.
		,, ,,	,, 6 ,,	,,	0.370	1.5	14.0	.107	...	8.8	Good state of preservation.
		,, ,,	,, 1 ,,	,,	0.101	2.7	12.6	.214	...	8.0	Good state of preservation. Small yield.
		,, ,,	,, 2 ,,	,,	0.121	1.7	13.8	.123	...	8.8	Good state of preservation. Small yield.
		,, ,,	,, 1 ,,	,,	0.090	2.3	13.5	.171	...	8.6	Good state of preservation. Small yield
		,, ,,	,, 1 ,,	,,	0.121	2.2	13.7	.161	...	8.8	Good state of preservation. Small yield
		,, ,,	,, 2 ,,	,,	0.152	1.9	15.2	.125	...	9.7	Fair state of preservation. Large yield.
		,, ,,	,, 2 ,,	,,	0.178	1.9	14.8	.128	...	9.4	Fair state of preservation. Large yield.
		,, ,,	,, 1 ,,	,,		Fermenting					Large yield 1 gm. insufficient to arrest fermentation and inversion.
		,, ,,	,, 1 ,,	,,		,,					
		,, ,,	,, 4 ,,	,,	0.201	2.7	14.5	.186	...	9.2	Good state of preservation.
		,, ,,	,, 4 ,,	,,	.212	2.9	14.0	.203	...	8.9	Good state of preservation.
		,, ,,	,, 4 ,,	,,	.228	4.8	13.8	.348	...	8.8	Examined in the Laboratory. 36 hours after collection.
		,, ,,	,, 4 ,,	,,	.234	3.8	16.0	.238	...	10.2	Good state of preservation. 10 hours after collection.

A Preliminary Note on the Sugar Palm.

By

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and

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The sugar palm, *Arenga saccharifera* Labill. occurs in "kampong" land throughout the Malay Peninsula. It is commonly planted by Malays for domestic use. Ridley records this species as apparently wild in Province Wellesley but he notes that the stems of these palms were more slender and less provided with fibre than in the typical plant (*Flora Mal. Pen.* Vol. V, page 19). The cultivated palm is known to the Malays as "Kabong" whereas the wild form is called "Enau." A distinct species *A. Westerhouti* Griff. "langkap," (Malay) is commonly met with on the hills but is of little or no economic importance.

Description and Uses.—The sugar palm is characterised by its large ascending, pinnate leaves and stout stem, covered with black fibre, reaching a height of 30 feet. The stem is usually solitary. The large pendulose inflorescence, 3 to 4 feet long, is produced from the axil of the leaves. The green fruits are produced in great abundance on the female inflorescence and become yellow in colour as they mature. Each fruit contains several black seeds about 1 inch long.

Various parts of the palm are used by Malays for a variety of purposes. The black horsehair—like fibre, produced at the base of the petioles, is used for making rope and twine, and is specially valuable to fishermen owing to its resistant qualities to the action of salt water.

Sugar and molasses (gula Malacca) are obtained from the flower shoots.

The interior of the immature fruits are commonly made into a sweetmeat by boiling with sugar. Several other uses are made of the palm but these are the most important.

Cultivation at the Government Plantation, Serdang.

The following information has been obtained from a small block of palms (9½ acres) planted on low-lying, flat land composed of a stiff loam at the Government Plantation, Serdang.

Seedling palms were planted during October, 1922, at a planting distance of 20 feet by 20 feet, allowing 108 palms to the acre. This distance has proved to be rather too close and a planting distance of 25 feet by 25 feet, triangular planting is recommended, especially on fertile land.

The first flower spathes were observed in March, 1928, i.e., 5½ years after planting in the field; the palms have flowered more freely during 1929, though so far only a small proportion have reached maturity i.e., the flowering stage.

Collection of Juice at Serdang.

The approximate period between the opening of the spathe to the commencement of tapping is 70 days. Male and female spathes, and spathes with male and abortive female flowers occur and have been tapped.

The juice is mainly obtained from the male spathes although certain of these failed to yield any sap. The female spathes give very small quantities of sap only. The spathes with male and abortive female flowers have been found to yield practically no sap. After the commencement of tapping the spathes, the juice flows for a period of 1½ to 2 months.

Prior to the commencement of tapping the spathe selected is beaten with a wooden mallet for a short time each day. This operation continues for two weeks, in order to stimulate a greater flow of sap into the peduncle.

When the flowers in the spathe open, the stem is severed at the base of the inflorescence and the cut end inserted into an earthenware pot as used by toddy collectors. The exudation of sap during the first and second day is slight but on the third day a large flow occurs. A thin slice is removed from the end of the stalk twice daily during the period that the sap continues to flow. This lasts, as has already been stated for 6 to 8 weeks.

A writer in the *Agricultural Bulletin, F.M.S.* Vol. I, page 191, (1912) describes the operation of tapping the palm as employed by Malays as follows:—

"On the appearance of the first spadix, the trunk and spadix are beaten twice a day until the flowers open, these are cut away and the liquid is led by means of fibre cords to receptacles placed on the ground to receive it. The beatings continue twice daily until the spadix is exhausted. If the flow stops or decreases, the stem of the spadix is again cut a little lower down.

The liquid obtained is usually collected in bamboos, these are previously smoked in order to arrest fermentation which takes place very quickly if the sap is exposed to the atmosphere for any time or is allowed to come in contact with any nitrogenous matter. It is collected every six hours and poured into iron dishes (Kualis), and heated until evaporation causes it to become a thick brownish, bubbling syrup, which solidifies on cooling. It is then poured into a series of wooden moulds (Achu-Gula), and allowed to cool. The sugar is then ready for consumption and is sold in the kampong shops at prices averaging from 9 to 12 cents per kati."

The flowering habits of the sugar palm are irregular and so far have not been examined critically at Serdang. Barrett states (*Philippine Agricultural Review*, Vol. VII, page 216) that of certain palms under observation in the Philippine Islands, about 90 per cent. were monoecious i.e., both male and female clusters were produced on the same palm. The remaining palms produced male spathes and abortive female flowers.

Preliminary tapping has so far only been undertaken but the following yields of sap are recorded from individual palms:—

YIELD OF SAP FROM PALMS

Palm number.	Spathes tapped.	No. of days tapped.	Quantity of sap in gallons.
248	Three male flowers	170	162
156	One male flower	34	3½
49	Two male flowers	29	4¼
103	One male flower	12	1
176	One male flower	12½	4
D	Two male flowers	29	25¾

K	One male flower	32	24
A	One male flower	14	9
B	One male flower	$36\frac{3}{4}$	$4\frac{3}{4}$
F	One male flower	50	$71\frac{1}{4}$
L	One female flower	8	1/6
305	One female flower	4	1/12
49	One female flower	9	$1\frac{1}{2}$
F	One flower, male and female in one bunch.	23	$\frac{3}{4}$

It will be seen that a high yield of sap occurs but considerable variability in yield from individual spathes is recorded. The female spathes, so far, have yielded comparatively no sap.

Two samples of juice from these palms, preserved with lime, were examined at the Department of Agriculture, Kuala Lumpur. The juice apart from a slight amount of lime in suspension was almost water clear and of a very pale yellow colour.

The following data was obtained:—

22.10.29.

Density compared with water at 84°F 1.0315 corresponding to approximate sugar content of 7.9.

CONSTITUENT PER 100 CC.

Saccharose	... 7.10 gm.
Invert Sugar	... 0.15 ,,
Non Sugars	... 0.29 ,,
Nitrogen	.... 0.005 ,,
Ash	... 0.021 ,,

29.10.29.

Density compared with water at 84°F 1.0200 corresponding to an approximate sugar content of 5.1.

CONSTITUENT PER 100 CC.

Saccharose	... 4.89 gm.
Invert Sugar	... 0.11 ,,
Non Sugars	... 0.21 ,,
Nitrogen	... 0.005 ,,
Ash	... 0.018 ,,

The ratio of Invert sugar to Saccharose is low, and the yield obtainable per palm is high, this seems to be counterbalanced to some extent by the sugar content which necessitates a large amount of evaporation compared with the sap of nipah or coconut.

Two litres of juice was evaporated under reduced pressure at 40—45°C. The sucrose crystallised out excellently and after centrifuging a good pale yellow sugar was obtained.

It is probable that it is for the reason of its good crystallising properties that it is so highly esteemed by Malays for making "gula Malacca". This latter has been prepared; one gallon of juice yielding about half a pound of sugar, corresponding to a total sugar content of five per cent.

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Laterite.

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During the last few months I have been asked so often by officers who are interested in soils to tell them briefly what "laterite" is that I decided to write a paper on the subject in reply to the query, in the hope that it will be of interest and some value to several officers of technical departments in Malaya.

In the first place let us deal with the origin of the word. It was first used in 1807 by F. Buchanan in "A Journey from Madras through Mysore, Canara and Malabar." In dealing with the iron-ore seen during his journey he wrote:—"In all the hills of the country the ore is found forming beds, veins, or detached masses in the stratum of indurated clay, that is to be afterwards described, and of which the greater part of the hills of Malabar consists.....What I have called indurated clay.....is one of the most valuable materials for building. It is diffused in immense masses, without any appearance of stratification, and is placed over the granite which forms the basis of Malayala. It is full of cavities and pores and contains a very large quantity of iron in the form of red and yellow ochres. In the mass, while excluded from the air, it is so soft, that any iron instrument readily cuts it, and is dug up in square masses with a pickaxe, and immediately cut into the shape wanted with a trowel, or large knife. It very soon after becomes as hard as a brick, and resists the air and water much better than any bricks I have seen in India .....As it is usually cut into the form of bricks for building, in several of the native dialects it is called the brick stone (Itica cullu).....The most proper English name would be laterite, from lateritis, the appellation that may be given to it in science."

The Latin root from which the word is derived is "latus," a brick or tile. Note that in the passage above it is clear that Buchanan meant the term to be applied to the "indurated clay" and not to the iron-ore. He says it contains a very large quantity of iron in the form of red and yellow ochres and describes how it hardens on exposure and is used for building in the form of bricks.

What Buchanan was describing is a common weathering product of rocks, found in most tropical countries. People who had seen the red and yellow indurated clay in India carried the word to other countries and applied it to red and yellow weathering product they saw there. Thus any red soil or soil mottled red and yellow came to be called laterite although it might not be possible to cut it into bricks, which was the real test of similarity of Buchanan's laterite, and, worse still, the name came to be applied to hard masses of iron-ore in red or mottled soils, especially by engineers, who in Malaya used to call them, and possibly still call them, "No. 1 laterite" because they form the best laterite road-metal. So here were two deviations already from Buchanan's original intention regarding the use of the word.

In India the use of the word spread, but it was not until 1903 that general interest in the chemical composition of laterite was aroused. In the Geological Magazine for that year Sir Thomas Holland had a paper on the "Constitution, Origin, and Dehydration of Laterite" in which he said that if the term "clay" is restricted to substances having a basis of hydrous silicate of alumina, it is wrong to call laterite "ferruginous clay" because in laterite the alumina exists, as in bauxite, in the form of hydrous oxides (op. cit. pp. 68, 69). He also said (p. 61) "Professor Bauer has now shown that laterite reproduces "the essential characters of bauxite."

In the same volume of the Geological Magazine H. and F. J. Warth published analyses of Indian laterites (pp. 154-159). On p. 159 they wrote:—"Laterite is bauxite in various degrees of purity, from the richest Wocheinite down to such specimens in "which the free alumina has entirely disappeared. It will make this paper easier to follow if I add that bauxite is an amorphous hydrate (hydrous oxide) of aluminium generally having the composition Al_2O_3. $2H_2O$, while there are two other, but crystalline hydrates of aluminium, disapore (Al_2O_3. H_2O), and gibbsite (Al_2O_3. $3H_2O$). Wocheinite is a very pure bauxite, grey, with very little iron oxide. "Free alumina" here means Al_2O_3 not combined with silicic acid or any other acid radicle, but it may be combined with water.

The great majority of people who had come to use the term "laterite" as a common word, engineers, agriculturists

and others probably never heard of those analyses at all; but among geologists, those, and other analyses, gave rise to an unfortunate idea that all laterite contained a high percentage of aluminium hydrate, and that if a decomposition product did not contain a high percentage of aluminum hydrate it should not be called laterite. This latter dictum was queried and a controversy on the subject arose, which lasted for at least two years and was summarised by Dr. L. L. Fermor in 1911 (Geological Magazine pp. 454, 507 and 559), but unfortunately this author, in an endeavour to clarify the position, suggested the use of two new terms, "lateritoid" and "lateritite" which, if adopted, would have made matters worse than ever.

In spite of efforts to prevent it the idea spread among geologists that laterite was essentially a weathering product containing a high percentage of aluminium hydrate; but in 1923, Dr. C. S. Fox published a memoir on "The Bauxite and Aluminous Laterite Occurences of India" (Memoirs of the Geological Survey of India. Vol. xlix, part I). In this work Dr. Fox illuminates the position regarding Indian laterite. It it contains enough aluminium hydrate to be used as aluminium-ore it should, he says, be called bauxite (this had been previously suggested by Dr. Fermor), and his use of the term "aluminous laterite" shows that he regards that as a special kind of laterite, not typical laterite. On p. 5 he writes:—"Practically all the bauxites or aluminous laterites occur associated with primary laterite—those which have been formed from various types of rock *in situ*. These bauxite segregations constitute an exceedingly small proportion of the primary laterite of the country. A very small percentage of the secondary laterites have enrichments of aluminous laterite suitable for use as bauxite." So the laterite rich in aluminium hydrate which caused so much interest in 1903 is described in 1925 as "an exceedingly small proportion" of primary laterite and "a very small percentage" of secondary (detrital) laterite. If that is so, and I have no reason to suppose that Dr. Fox is wrong, it is impossible to take richness in aluminium hydrate as the leading characteristic of laterite and it appears to me that popularisation on the one hand and enthusiasm over a few analyses on the other have destroyed the value of "laterite" as a scientific term; while those geologists who insisted on a high percentage of aluminium hydrate as the test of laterite are as far from Buchanan's intention as to the use of the word which he originated, as are engineers who call masses of iron oxide in the soil "No. 1 laterite."

In Malaya we have some laterite that fits Buchanan's definition exactly, in Malacca Territory,* where schists, and granitic rocks weather to a red and yellow mottled mass which, in the case of the schists and perhaps to a small extent of the granite, can be quarried and used as Buchanan describes. But it is certain that the bulk of the alumina is combined with silica, and is not present as free aluminium hydrate. Superficially it closely resembles specimens I have seen of Indian laterite. An analysis by Mr. J. C. Shenton of this Malacca laterite, over schists, is as follows:—

Silica	...	23.60%
Titanium dioxide	...	.86%
Ferric oxide	...	37.94%
Alumina	...	21.60%
Manganese	...	trace
Lime	...	1.20%
Zirconia	...	trace
Magnesia	...	.45
Sulphuric Anhydride	...	3.36
Potash	...	.34
Soda	...	.37
Water and loss on ignition	...	11.20
		100.92

Among geologists I think it is generally assumed now that if "laterite" is mentioned, something containing aluminium hydrate is referred to—quite wrongly—but others may refer to a red or yellow soil or to an iron-oxide, and I think that for scientific work the term would be much better dropped.

But from under all this confusion there is one definite piece of information that has emerged, and that is that under certain conditions silicate-rocks produce aluminium hydrate as a final weathering product instead of hydrous aluminium silicates. What those conditions are is not yet certain. Some say tropical conditions are necessary but that is not proved; or that alternation of wet and dry seasons is required, but that is not proved either. The formation of aluminium hydrate, however, is more marked in rocks with a low, than with a high silica percentage. The change that takes place is a step

*Newbold, in "British Settlements in Malacca (1839) quotes Dr. Ward as saying that the Malacca laterite is exactly the same as the rock on the Malabar Coast described by Buchanan as "laterite."

beyond the formation of the hydrous silicate, which is broken down, silica being carried off in solution, and hydrate remaining.

In Malaya, in Indo-China, and in the Netherlands Indies the change in "acid," granitic rocks, which have a high percentage of silica, does not go beyond the formation of hydrous silicate of alumina, except perhaps for a small proportion hard to prove, and therefore the soil is clayey owing to the presence of kaolinite and perhaps halloysite. In less acid or "basic" rocks, on the other hand, when weathered, there is an appreciable amount of aluminium hydrate; but it is curious that the only occurrence of hydrate in large percentage in Malaya is as nodules of a white or creamy colour above schists e.g. at Redhills, Kinta, Rawang, and in Malacca—which are of no economic importance. In Kuantan is situated the only large area where basic rocks form the soil. This is about 30 square miles of soil derived from dolerite, north and north-west of the township of Kuantan. The soil resembles the volcanic soils of Java, being derived from a similar rock.

But what particularly concerns us here is whether laterite in any sense of the word, is of importance in agriculture and forestry. Rocks supply three important plant-foods, calcium carbonate ($CaCO_3$), potash (K_2O), and phosphorus pentoxide (P_2O_5). Iron and magnesia are of minor importance, and as far as I am aware, alumina is of no importance as a plant-food.

First consider the red, yellow, and mottled soils formed over "acid rocks." Here we are dealing really with ordinary soils and we expect to get a little $CaCO_3$ only, a little P_2O_5, but more K_2O. The hydrous silicate of alumina derived from felspar makes the soils rather clayey unless grains of quartz are abundant.

The same is true for the laterite in Malacca and generally for soils over schists, as for soils over acid rocks.

The masses of iron ore referred to as "laterite" by engineers we need not consider.

Is bauxite, or an aluminous laterite, a good soil? Bauxite is essentially Al_2O_3 H_2O with Fe_2O_3, SiO_2, P_2O_3, CaO, and MgO as common impurities (Dana. System of Mineralogy p. 251).

The analyses of H. and F. J. Warth of certain Indian laterites, which can be described as bauxites and aluminous laterites, show as the main constituents Al_2O_3, Fe_2O_3, H_2O, SiO_2, TiO_2. CaO and MgO are unimportant; P_2O_5 and K_2O are not mentioned.

If the volcanic soils of Java and Kuantan are considered to be laterite on the ground that they contain much aluminium hydrate, then is their richness as soils due to that hydrate? Chemically it is not; the rocks from which the soils are derived yield more $CaCO_3$ and P_2O_5 than acid rocks, and are therefore richer.

As a source of plant foods, therefore, laterite is not of special importance; but mechanically it may be of considerable importance in soils. It may be beneficial or the reverse.

In the case of a weathering product rich in aluminium hydrate the proportion of "clay" is small, or it may be absent altogether. The result is that such soils are earthy, open and porous. In the case of Kuantan dolerite soil this may be of importance in allowing the free circulation of plant foods and perhaps in aeration and growth of roots, but such soils in Malay generally contain a fair amount of particles small enough to be classed as clay in mechanical analysis. But at the same time they are distinctly friable.

On the other hand soils are frequently so impregnated with iron-oxide that their porosity is reduced or destroyed altogether, which must have a bad effect on vegetation. In the latter case the so-called "laterite" is nothing more than the "iron-pans" of Europe, which are often a source of trouble to agriculturists.

In conclusion I would suggest that the word laterite be used as little as possible. In Malaya we have typical laterite as defined by Buchanan, but it is only weathered rock impregnated with iron-oxide, and contains a large amount of hydrous silicate of alumina or "clay." On the other hand the word is applied popularly to masses of iron-oxide and red decomposition products which are simply ordinary soils coloured by Fe_2O_3. The formation of large quantities of aluminium hydrate may be of importance mechanically in a soil, but it is unnecessary, and incorrect, to associate that with Buchanan's word "laterite."

STATION.		Percentage.			Rainfall. Total.		Most in a day. Amount.	Most in a day. Date.	No. of rainfall days.	Bright Sunshine. Daily mean.	Bright Sunshine. Total.
		9 A.M.	3 P.M.	9 P.M.							
		%	%	%	Ins.	m.m.	m.m.			Hrs.	Hrs.
PERAK—											
Taiping	...	80	77	61	89	6.46	164.0	54.5	24th	10	..	..
Kuala Kangsar	...	76	81	53	90	3.56	90.5	48.0	11th	3	..	..
Batu Gajah	...	79	76	54	89	3.32	84.5	23.8	30th	9	..	..
Gopeng	...	80	76	58	94	3.54	89.9	32.0	24th	12	..	..
Ipoh	...	79	76	53	94	6.16	156.4	50.9	5th	10	..	..
Kampar	...	78	80	57	87	3.86	98.1	21.1	20th	10	..	..
Teluk Anson	...	77	84	60	94	5.06	128.5	37.5	25th	7	..	..
Tapah	...	80	73	62	94	7.34	186.5	41.9	3rd	14	..	..
Parit Buntar	...	80	78	62	95	1.67	42.4	24.4	2nd	3	..	..
Bagan Serai	...	78	84	72	93	2.47	62.7	15.7	4th	6	..	..
Selama	...	78	81	63	90	2.67	67.8	34.0	2nd	6	..	..
Lenggong	...	76	83	56	88	1.44	36.5	24.5	11th	2	..	..
Tanjong Malim	...	78	84	63	92	8.00	203.2	74.4	3rd	13	..	..
Grik	...	74	87	62	87	1.25	31.7	21.3	3rd	4	..	..
Klian Intan	...	73	86	63	91	0.16	4.0	4.0	6th	1	..	..
Kroh	...	75	83	59	91	0.51	13.0	13.0	3rd	1	..	..
Tanjong Rambutan	...	78	77	51	83	4.71	119.6	46.2	24th	6	...	..
Sitiawan	...	81	77	69	98	1.18	29.9	22.9	7th	3	..	..
SELANGOR—											
Kuala Lumpur Rly. Hill	...	78	79	58	90	7.85	199.4	37.0	2nd	14	7.11	220.45
K.L. Inst. for Med. Research	...	79	76	55	90	5.50	139.7	47.0	1st	11	..	..
Bukit Jeram	...	80	77	70	88	4.63	117.6	84.4	6th	8	8.61	266.90
Kajang	...	78	85	65	95	7.07	179.6	53.6	2nd	10	..	..
Kuala Selangor	...	82	74	53	70	8.26	209.8	81.8	6th	12	..	..
Serendah	...	79	76	55	94	9.41	239.0	40.7	6th	11	..	..
Kuala Kubu	...	80	74	58	93	7.80	193.1	88.2	2nd	9	..	..
Telok Datoh	...		..	..	..	7.35	186.7	58.2	6th	13	..	..
NEGRI SEMBILAN—											
Seremban	...	82	80	65	95	8.56	217.5	77.4	1st	10	5.92	183.50
Kuala Pilah	...		..	..	..	6.44	163.6	73.2	2nd	11	..	..
Tampin	...	79	81	65	89	4.58	116.3	39.4	6th	8	..	..
Port Dickson	...	81	80	79	94	3.88	98.6	52.1	6th	5	..	..
Jelebu	...	77	86	61	94	11.52	292.6	71.4	6th	7	..	..
PAHANG—											
Kuala Lipis	...	77	86	60	89	3.83	97.3	40.7	1st	6	..	..
Raub	...	75	85	63	95	8.22	208.8	87.4	3rd	9	..	..
Bentong	...	76	86	58	95	4.51	114.9	45.7	3rd	9	..	..
Pekan	...	79	82	63	91	9.22	234.6	66.6	6th	7	..	..
Kuantan	...	77	81	70	88	9.27	235.5	104.1	2nd	8	..	..
Temerloh	...	76	85	59	85	2.39	60.7	32.3	6th	9	6.71	207.90
HILL STATIONS—											
Cameron's H'lands (Tanah Rata)		65	77	70	93	3.79	96.4	27.8	2nd	12	6.31	195.60
Cameron's H'lands (Bt. Mentigi.)		64	76	75	..	3.92	99.6	28.0	2nd	10	6.75	208.90
Fraser's Hill	...	62	93	86	94	8.66	220.0	50.8	6th	17	5.53	171.35
Maxwell's Hill	...	69	75	84	89	8.47	215.1	100.4	2nd	7	..	..

—	Total.		Most in a day.	Date.	Negri Sembilan. Total.	Most in a day.	Date.	No. of rainfall days.
	Ins.	m.m.	m.m.		m.m.	m.m.		
Kuala Kurau ..	8 36	85.2	38.9	2[illegible]	148.9	70.4	2nd	7
The Cottage ..	11.20	284.5	117.9	1[illegible]				

—	Pahang. Total.		Most in a day.	Date.	No. of rainfall days.
	Ins.	m.m.	m.m.		
Mentakab ..	2.65	67.3	31.8	6th	6
S. Lembing.	6.83	173.5	59.7	6th	12
Rompin ..	7.02	178.3	66.1	7th	8